CA88-11/30/88
PRD 980594709
7H

Golder Associates Inc.
CONSULTING ENGINEERS

REPORT ON

OCCURRENCE OF KARST FEATURES IN THE PONCE FORMATION PONCE MUNICIPAL LANDFILL PONCE, PUERTO RICO

BFI

Submitted to:

BFI of Ponce, Inc.
757 North Eldridge
Houston, Texas 77079

DISTRIBUTION:

2 Copies - BFI, Houston, Texas
1 Copy - BFI of Ponce, Puerto Rico
2 Copies - U.S. EPA, Region II
1 Copy - Golder Associates Inc.

November 1988

883-3643.13

Golder Associates, Inc.
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

12/1

November 30, 1988

883-3643.13

U.S. Environmental Protection Agency
Region II
26 Federal Plaza
New York, NY 10278

Attention: Mr. Stanley Siegel, Chief
Hazardous Waste Facilities Branch

RE: MUNICIPAL LANDFILL OF PONCE
EPA I.D. NUMBER: PRD 980594709

Gentlemen:

As agreed upon in the meeting between BFI of Ponce, Inc. and the U.S. Environmental Protection Agency, Region II, on July 25, 1988, please find enclosed two copies of the report on Occurrence of Karst Features in the Ponce Formation submitted on behalf of BFI of Ponce, Inc.

BFI of Ponce, Inc. will cooperate fully during the Agency's review in order that the report may be approved in an expeditious manner.

Please feel free to contact Mr. Bruce Jernigan at (713) 870-8100 or myself if you require any assistance in this matter.

Very truly yours,

GOLDER ASSOCIATES INC.

W. R. Sullivan

W. Randall Sullivan, P.E.
Associate

WRS/r

Enclosure

cc: Mr. Bruce Jernigan

Golder Associates Inc.
CONSULTING ENGINEERS

November 30, 1988 883-3643.13

BFI of Ponce, Inc.
757 North Eldridge
Houston, TX 77079

Attention: Mr. Bruce Jernigan

RE: REPORT ON OCCURRENCE OF KARST FEATURES
IN THE PONCE FORMATION
PONCE MUNICIPAL LANDFILL
PONCE, PUERTO RICO

Gentlemen:

At the request of the U.S. Environmental Protection Agency, Region II (EPA) in a meeting on July 25, 1988, enclosed please find two copies of the report on the regional occurrence of solution cavities within the Ponce Formation. We have also forwarded two copies of the report to EPA for their review and comment.

Please do not hesitate to call us if we can be of help in any way. We appreciate the opportunity to continue assisting BFI on this project.

Very truly yours,

GOLDER ASSOCIATES INC.

Scott D. Sumner
Geological Engineer

W. Randall Sullivan, P.E.
Associate

SDS/WRS/r

Enclosure

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1.0 INTRODUCTION

This report represents an existing data review of potential karst type features within the Ponce Formation in the southern portion of Puerto Rico. The scope of this report includes review of pertinent geologic literature available on the Ponce Formation, discussions with a water resources specialist from the San Juan, Puerto Rico USGS office, and discussions with the local speleological society chairman. This study is part of a larger work program being performed as a RCRA Facility Assessment (RFA) for the Ponce Municipal Landfill (the site).

The purpose of this report is to: 1) determine the general occurrence, size, and orientation of solution cavities in the Ponce Formation on a regional basis; and 2) determine the possible impacts of karstified Ponce Formation at the site.

2.0 SITE DESCRIPTION

2.1 Site Location

The site is located on Avenue Baramaya, Barrio La Cotorra, in the south central portion of Puerto Rico, 1 to 2 km (0.6 to 1.2 miles) outside the city limits of Ponce, and 3 km (1.8 miles) north of the Caribbean Sea (Figure 1). The site covers an area of 51 ha (125 acres) with approximately two-thirds of the area being covered by refuse and fill.

The layout of the site is shown on Figure 2, Site Plan. The approximate limits of the landfill are designated on the Site Plan, indicating filling of a valley. Site workshops, offices and other facilities are located at the eastern end of the site. The unused hazardous waste cell (Cell 1), excavated during 1983-84 is located on the south side of the site. Current borrow areas for cover material are located to the northeast and southwest of the landfill.

2.2 Aerial Distribution of Ponce Formation

The Ponce Formation is continuously exposed from the Rio Pastillo River valley east of the site to Bahia Montalva approximately 8 km (5 miles) west of Guanica except where it is covered by alluvium in the river valleys.[1] (See Figure 3, Note: This figure does not distinguish Ponce Limestone from Juana Diaz Limestone.) Exposure of these limestone formations have also been noted at several isolated areas to the east of the city of Ponce, most likely due to displacement of the formation along fault zones predominant to southern Puerto Rico.

3.0 FORMATION DESCRIPTION

3.1 Lithologic Origin

The Ponce Formation was originally deposited as a fringing reef and is a predominantly pure limestone of about 96 percent calcium carbonate.[2] The limestone, as it appears in outcrops, consists of a recrystalized, very hard, generally light grayish-orange fossiliferous material.

3.2 Geology

Several extensive investigations have been performed in order to accurately depict the geological make-up of the Ponce Formation, as noted in the July, 1988 Hydrogeologic Review submitted by Golder Associates as part of the RFA. Briefly, the Miocene-aged Ponce Formation unconformably overlies the Oligocene/Miocene-aged Juana Diaz Formation in the region. The site contains several high-angle normal faults with a major fault that has 200 m (650 feet) of vertical displacement and possibly a left-lateral component. In the river valleys, the Ponce Formation is partially covered by Quarternary-aged alluvium. Figure 4 shows the distribution of the Ponce Formation, Juana Diaz Formation, and the alluvium at the site.

3.3 Stratigraphy

Stratigraphically, the Ponce Formation consists of three (3) distinct geologic units, those being a lower unit of homogeneous light gray and brown, hard calcareous silt, a middle unit similar in composition to the lower unit but very hard and brittle at its base, and an upper unit, which is generally orangish-brown, porous, and fossiliferous. More detailed stratigraphic information is presented in the previously submitted Hydrogeologic Review, July, 1988.

3.4 Formation Thickness

The thickness of the Ponce Formation is reported to be at least 200 m (650 feet) thick.[3] More accurate thickness determinations of the formation have not been confirmed due to erosion and faulting of the formation. At the site, the Ponce Formation is thought to be a maximum thickness of approximately 85 m (280 feet) at boring C-15 (see Figure 5), although regrading of the original site topography has disturbed much of the Ponce Formation outcrops (see Figure 6).

3.5 Hydrology

A detailed description of the drainage patterns and hydraulic composure of the site is explained in the previously submitted Hydrogeologic Review, July 1988. Briefly approximately 90% of the site drains into the Rio Pastillo River basin to the east of the site with the remaining 10% draining into the Quebrado del Agua to the west of the site. However, the Rio Pastillo is an intermittent river, flowing only approximately 30% of the year due to precipitation run-off.

3.6 Hydrogeology

The previously submitted Hydrogeologic Review, July 1988, as well as several other previously submitted reports describe the hydrogeology at the site in detail. Tables 3 and 4 give information available concerning groundwater potentiometric surface elevations and the corresponding calculated formation hydraulic conductivity coefficients for several of the monitoring wells and borings, respectively. Additional water level readings have been included in Appendix B. The groundwater, based on the few monitoring wells on site as shown in Figure 7, seems to indicate general flow direction to the

southeast. Information available with respect to regional groundwater flow directions as shown in Figure 8 support this interpretation.

3.7 Mineralogy

Table 1 shows the results of chemical analyses performed on three samples from a roadside cut in the Ponce Limestone.[4] The table indicates that the limestone consists predominantly of calcium oxide (CaO) and carbon dioxide (CO_2), which together make up an average of 90%+ of the chemical composition of $CaCO_3$. Also, the three samples have relatively low acid insoluble percentages, indicating that the samples would be potentially susceptible to solution activity.

3.8 Geochemistry

Analytical results for groundwater sampling of monitoring wells located at the site have been included as Appendix A. In addition, analytical results for landfill composite samples and roadway sidewall composite samples have been included. A detailed description of the sampling and analyses can be found in the previously submitted Hydrogeologic Review, July 1988. Conclusions to these analytical results are left to the reader.

4.0 KARST FACTORS

4.1 Limestone Solubility

As previously stated in the report, the Ponce Formation is a relatively pure calcium carbonate limestone readily susceptible to solutioning. However, the development of karst features requires that water with dissolved CO_2 infiltrate into the subsurface material in order to interact with the calcium carbonate as shown:

$$CaCO_3 + CO_2 + H_20 \quad Ca^{+2} + 2HC0_3^-$$

The generation of the carbonic acid (HCO_3^-), which would lower the formation pH and thus enhance solution activity of the limestone, is a direct result of the amount of water that infiltrates through the formation.

4.2 Climate

Climatic information, as presented in the Hydrogeologic Review, July 1988, indicate trade winds blowing predominantly from the northeast and southeast, approximately 60% of the winds with velocities ranging from 6 to 19 km/h (4 to 12 mph) and averaging 8 km/h (5 mph). Also, temperatures remain relatively constant throughout the year, averaging nearly 26°C (80°F).

Rainfall and pan evaporation data for the years 1983 through 1987 for the Ponce City area (Table 2) indicate relatively large monthly evaporation rates compared to monthly precipitation data. Evapotranspiration results in a net loss of moisture. Much of the precipitation is lost through evaporation instead of infiltrating into the subsurface formations and thus, has not been available to react with the Ponce Formation to produce karst features.

4.3 Identified Karst Features

The Ponce Formation is a recrystallized reef limestone that generally resists erosion. Hence, the formation appears in outcrops as steep-sided hills characterized by small north-facing cuesta scarps.[5] In large outcrop regions, steep-sided canyons exhibiting nearly vertical-walled cliffs can be seen. Many of the cliff faces exhibit minor karst features such as scooped-out solutional scars, several kinds of karren and solutions pans, and rock shelters present.

In addition to these inland type karst features, several distinctive solutional features are well shown along the southern coast of Puerto Rico, resulting from Ponce Formation which has been exposed to wave action and/or sea spray.[7] These include solution pans, pinnacles, small sea caves, karren spikes, and arches.

Formation boring descriptions from the test boring records for monitoring well MW-5 and boring C-15 (Appendix B and Figure 5, respectively) make no mention of having encountered any karst features. Therefore, it can be concluded that the Ponce Formation has not undergone any solutioning at these locations which would result in karst-type features.

Telephone interviews with Carlos Conde, a local USGS Water Resources Specialist, and Chairman of the Puerto Rico Speleologists Society revealed that there are no known caves, sinkholes, or other such karst features identified in the Ponce Formation.

5.0 CONCLUSIONS

The purpose of this report was to determine the general occurrence of solution cavities in the Ponce Formation and determine what impacts such karst features would have on the Ponce Formation.

The Ponce Formation is a karstifiable limestone and would have many more karst features than have been observed if it were in a wetter climate. However, the arid inland climate of southern Puerto Rico has established an environment only capable of producing minor karst features such as rock shelters, karren, and scooped-out solution scars in the Ponce Formation. These minor features will most likely have very minimal impact on the water transmitting capacity of the Ponce Formation and then only near the surface where the formation is exposed to intermittent precipitation. Additionally, no subsurface karst features have been observed during subsurface investigations that would lead to the conclusion that there are no known karst features within the Ponce Formation.

GOLDER ASSOCIATES INC.

Scott D. Sumner
Geological Engineer

Charles A. Spiers, P.G.
Associate

SDS/CAS:maa

REFERENCES

1. Monroe, Watson H. Geological Survey Professional Paper 953 - Geology of the Middle Teritary Formation of Puerto Rico, U.S. Government Printing Office: Washington, D.C., 1980 p. 78.

2. Monroe, p. 14.

3. Monroe, p. 81.

4. Monroe, p. 80.

5. Monroe, . 82

6. Monroe, Watson H., Geological Survey Professional Paper 899 - The Karst Landform of Puerto Rico, U.S. Government Printing Office: Washington, D.C., 1976, p. 58.

7. Monroe, p. 55

8. Conde, Carlos, Environmental Health Scientist, United States Geological Survey, San Juan, Puerto Rico office; Water Resources Environment Specialist and Chairman of Puerto Rico Speleological Society, October 6, 1988.

TABLE 1

CHEMICAL ANALYSES OF PONCE LIMESTONE

Lab No. Field No.	W175020 PE278[1]	W175012 PV7[2]	W175013 PV141[3]
SiO_2	0.91	5.5	0.15
Al_2O_3	.34	1.1	.05
Fe_2O_3	.26	.42	.07
FeO	.04	.02	.04
MgO	.44	4.4	6.7
CaO	53.4	44.4	46.6
Na_2O	.13	.33	.03
K_2O	.00	.32	.00
H_2O-	.10	.60	.08
H_2O+	.40	.70	.43
TiO_2	.00	.02	.00
P_2O_5	.03	.04	.02
MnO	.00	.06	.05
CO_2	42.9	40.9	45.0
TOTAL	99.	99.	99.
Acid Insoluble	1.5	7.1	0.3

[1] Cut on south side of Highway 2, 1.6 km west of Rio Tallaboa, (119,430 E., 20,190 N. Penuelas quardrangle).

[2] Cut on north side of Highway 335, 1 km northwest of Central San Francisco (110,670 E., 17,350 N., Punta Verraco quadrangle).

[3] Recrystallized limestone, north side of jeep trail, 1.9 km west-southwest of Punta Ventana (110,180 E., 13, 540 N., Punta Verraco quadrangle).

Ref: USGS Professional Paper 953, 1980, P. 80.

TABLE 2
PAGE 1 OF 2

MONTHLY RAINFALL AND EVAPORATION DATA FOR 1983-1987
FOR THE PONCE AREA

DATE	PRECIPITATION (mm)	PAN EVAP (mm)	PRECIPITATION (in.)	PAN EVAP (in.)
1/83	16.51	146.05	0.65	5.75
2/83	5.33	139.95	0.21	5.51
3/83	56.90	175.51	2.24	6.91
4/83	200.66	175.77	7.90	6.92
5/83	87.38	143.00	3.44	5.63
6/83	74.42	201.42	2.93	7.93
7/83	56.13	188.72	2.21	7.43
8/83	101.09	191.77	3.98	7.55
9/83	42.16	189.74	1.66	7.47
10/83	104.65	157.23	4.12	6.19
11/83	250.95	128.78	9.88	5.07
12/83	16.26	123.95	0.64	4.88
1/84	49.02	144.53	1.93	5.69
2/84	23.37	147.57	0.92	5.81
3/84	34.04	199.90	1.34	7.87
4/84	27.18	198.37	1.07	7.81
5/84	73.91	170.43	2.91	6.71
6/84	28.70	187.20	1.13	7.37
7/84	71.63	212.09	2.82	8.35
8/84	57.15	220.47	2.25	8.68
9/84	314.45	149.35	12.38	5.88
10/84	50.80	155.96	2.00	6.14
11/84	410.46	131.57	16.16	5.18
12/84	11.94	131.83	0.47	5.19
1/85	2.54	137.67	0.10	5.42
2/85	29.97	147.83	1.18	5.82
3/85	54.10	182.88	2.13	7.20
4/85	26.16	189.99	1.03	7.48
5/85	167.39	202.69	6.59	7.98
6/85	2.79	193.80	0.11	7.63
7/85	26.16	209.55	1.03	8.25
8/85	71.37	210.82	2.81	8.30
9/85	175.77	166.62	6.92	6.56
10/85	325.37	138.68	12.81	5.46
11/85	52.58	136.91	2.07	5.39
12/85	0.25	144.53	0.01	5.69
1/86	11.94	136.40	0.47	5.37
2/86	22.10	149.61	0.87	5.89
3/86	7.11	203.20	0.28	8.00
4/86	38.35	199.64	1.51	7.86
5/86	250.70	175.51	9.87	6.91

TABLE 2
PAGE 2 OF 2

MONTHLY RAINFALL AND EVAPORATION DATA FOR 1983-1987
FOR THE PONCE AREA

DATE	PRECIPITATION (mm)	PAN EVAP (mm)	PRECIPITATION (in.)	PAN EVAP (in.)
6/86	30.48	187.96	1.20	7.40
7/86	17.27	225.04	0.68	8.86
8/86	72.39	221.74	2.85	8.73
9/86	55.88	192.28	2.20	7.57
10/86	78.23	172.72	3.08	6.80
11/86	135.64	128.02	5.34	5.04
12/86	59.18	148.08	2.33	5.83
1/87	52.32	153.42	2.06	6.04
2/87	36.32	154.43	1.43	6.08
3/87	29.46	192.02	1.16	7.56
4/87	23.37	202.18	0.92	7.96
5/87	127.00	160.27	5.00	6.31
6/87	202.69	166.37	7.98	6.55
7/87	15.49	216.92	0.61	8.54
8/87	19.56	228.60	0.77	9.00
9/87	69.34	193.55	2.73	7.62
10/87	204.72	159.26	8.06	6.27
11/87	349.00	123.95	13.74	4.88
12/87	49.28	123.95	1.94	4.88

NOTES:

1. DATA OBTAINED FROM NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
2. PRECIPITATION DATA IS FROM THE PONCE CITY STATION LOCATED ABOUT 4 KM (2 MI) EAST OF THE SITE.
3. PAN EVAPORATION DATA IS FROM THE PONCE 4E STATION LOCATED ABOUT 20 KM (12 MI) EAST OF THE SITE.

TABLE 3

GROUNDWATER LEVELS
MONITORING AND OBSERVATION WELLS

Well No.	First Water (m MSL)	Condition of Soil	Static Water Level (m MSl)	Date	Change in Elevation After First Encounter (m)	Formation Screened
MW-1	46.8	Dry	NA	-	NA	Juana Diaz
MW-2	63.6	Saturated	60.1	March 84	-3.6	Juana Diaz
MW-3	52.7	Saturated	55.3	March 84	+2.6	Juana Diaz
MW-4	52.6	Moist	51.3	March 84	?	Juana Diaz
MW-5	40.2	Dry	40.4	March 84	NA	Ponce
MW-6	21.9	Moist	14.1	March 84	?	Juana Diaz
MW-7	40.4	Saturated	51.7	March 84	+11.3	Juana Diaz
MW-8	4.6	Moist	46.9	March 84	+42.4	Juana Diaz
C-1	62.7	-	57.8	9-1-83	-4.9	Juana Diaz
C-3	32.8	-	26.3	9-1-83	-6.4	Juana Diaz
C-4	42.8	-	44.9	9-1-83	+2.1	Juana Diaz
C-5	65.8	-	58.2	9-1-83	-7.6	Juana Diaz
C-6	38.6	-	43.1	9-1-83	+4.5	Juana Diaz
C-15	6.2	-	5.9	9-1-83	-0.4	Ponce
C-16	16.1	-	38.6	9-1-83	+22.6	Juana Diaz

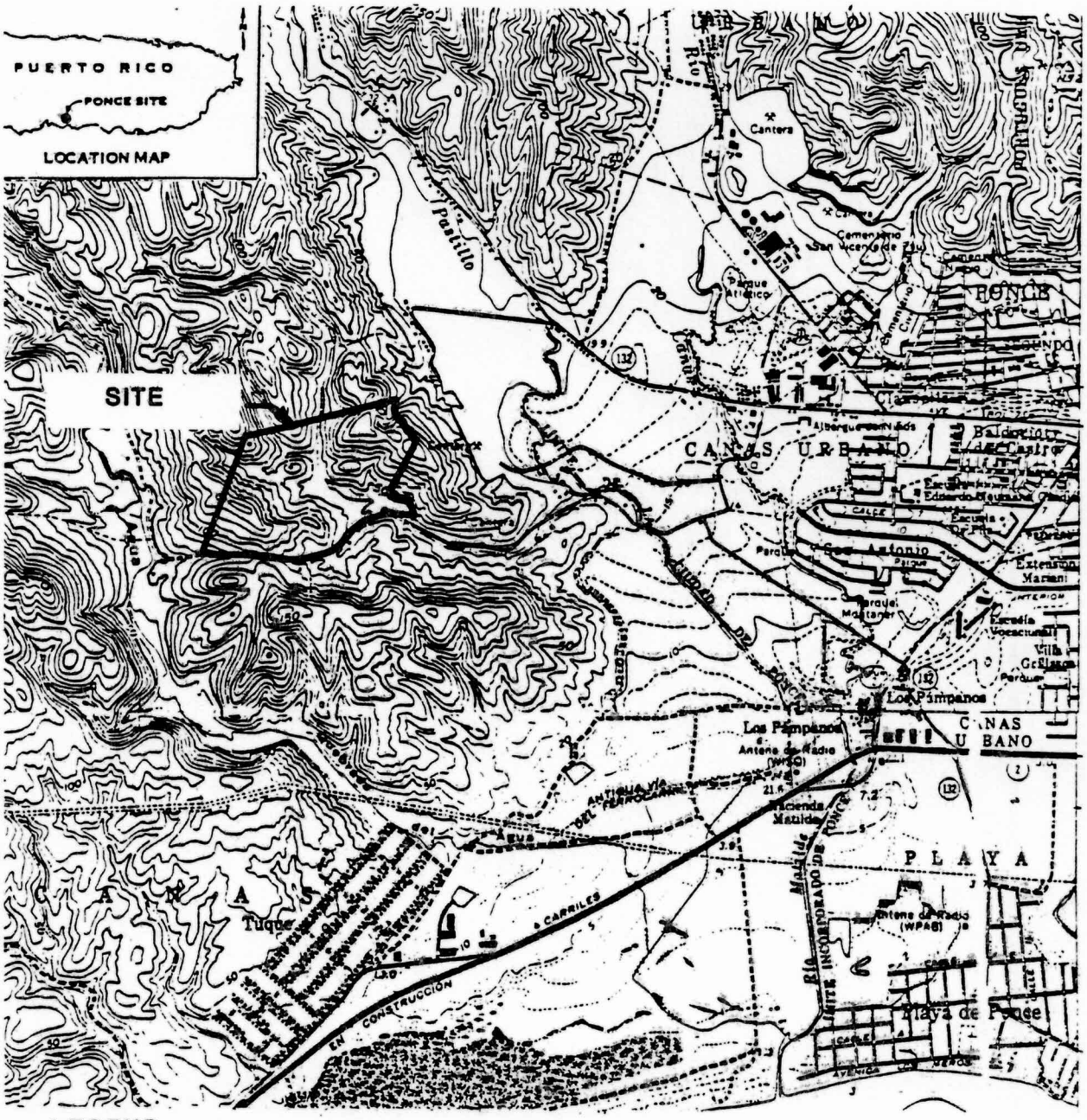
Ref: Law Engineering Testing Co.
Draft Report on Hydrogeologic Assessment/
Monitoring Well Installation,
Ponce Waste Facility, submitted to
Cecos International, Inc.

TABLE 4

HYDRAULIC CONDUCTIVITY

Well	Type of test	Initial test condition	K (cm/s)
MW-1	rising head	saturated	2.4×10^{-6}
MW-2	rising head	saturated	1.3×10^{-4}
MW-3	rising head	saturated	2.7×10^{-6}
MW-4	rising head	saturated	8.0×10^{-5}
	falling head	saturated	6.2×10^{-5}
MW-7	rising head	saturated	5.4×10^{-5}
	falling head	saturated	7.0×10^{-5}
MW-8	rising head	saturated	1.5×10^{-6}
C-8	falling head	unsaturated	9×10^{-9}
C-9	falling head	unsaturated	2×10^{-9}
C-84	falling head	unsaturated	2.7×10^{-7}
C-85	falling head	unsaturated	3.0×10^{-7}

Ref: Law Engineering Testing Co.
Draft Report on Hydrogeologic Assessment/
Monitoring Well Installation,
Ponce Waste Facility, submitted to
Cecos International, Inc.



LEGEND

— 100 — TOPOGRAPHIC CONTOUR INTERVAL = 10 METERS

REF:

TAKEN FROM USGS PENUELAS (1964) & PUNTA CUCHARA (1964) TOPO QUAD MAPS.

MILES 0 1

KILOMETER 0 1

SCALE

Golder Associates, Inc. Atlanta, Georgia			TITLE: SITE LOCATION MAP FOR PONCE MUNICIPAL LANDFILL		
CLIENT/PROJECT: BFI OF PONCE, INC.					
DRAWN: DRC	CHECKED: SDS	REVIEWED: WRS	DATE: 6/25/88	SCALE: AS SHOWN	JOB NO.: 883-3643
			FILE NO.: 883-3643	DWG. NO. / REV. NO.: 2	FIGURE: 1

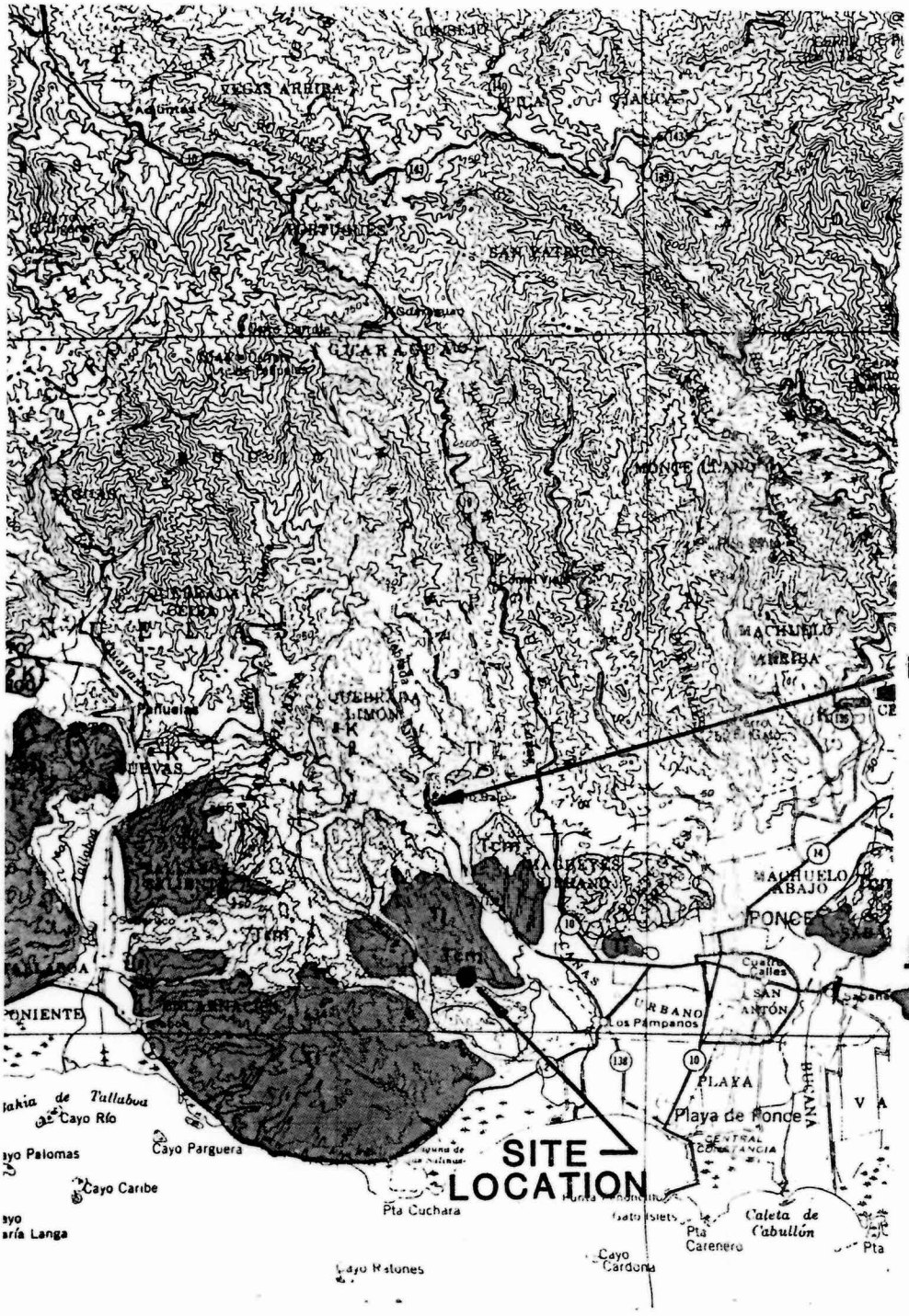
BASE MAP PREPARED FROM FEB., 1988 AERIAL PHOTOS.

BFI OF PONCE, INC.

TITLE

SITE PLAN FOR PONCE MUNICIPAL LANDFILL

DRAWN DRC	SCALE AS SHOWN	DATE 6/29/88
CHECKED SDS	REVIEWED WRS	JOB NO. 883-3643
Golder Associates		DWG NO. 3
		FIGURE 2



N

RIO PASTILLO

LEGEND

LIMESTONE OF MIOCENE AND OLIGOCENE AGE

5 10 KILOMETERS 15 20 25 30

CONTOUR INTERVAL 50 METERS

0 5 10 MILES

DATUM IS MEAN SEA LEVEL

Golder Associates Inc.
Atlanta, Georgia

CLIENT/PROJECT
BFI OF PONCE, INC.

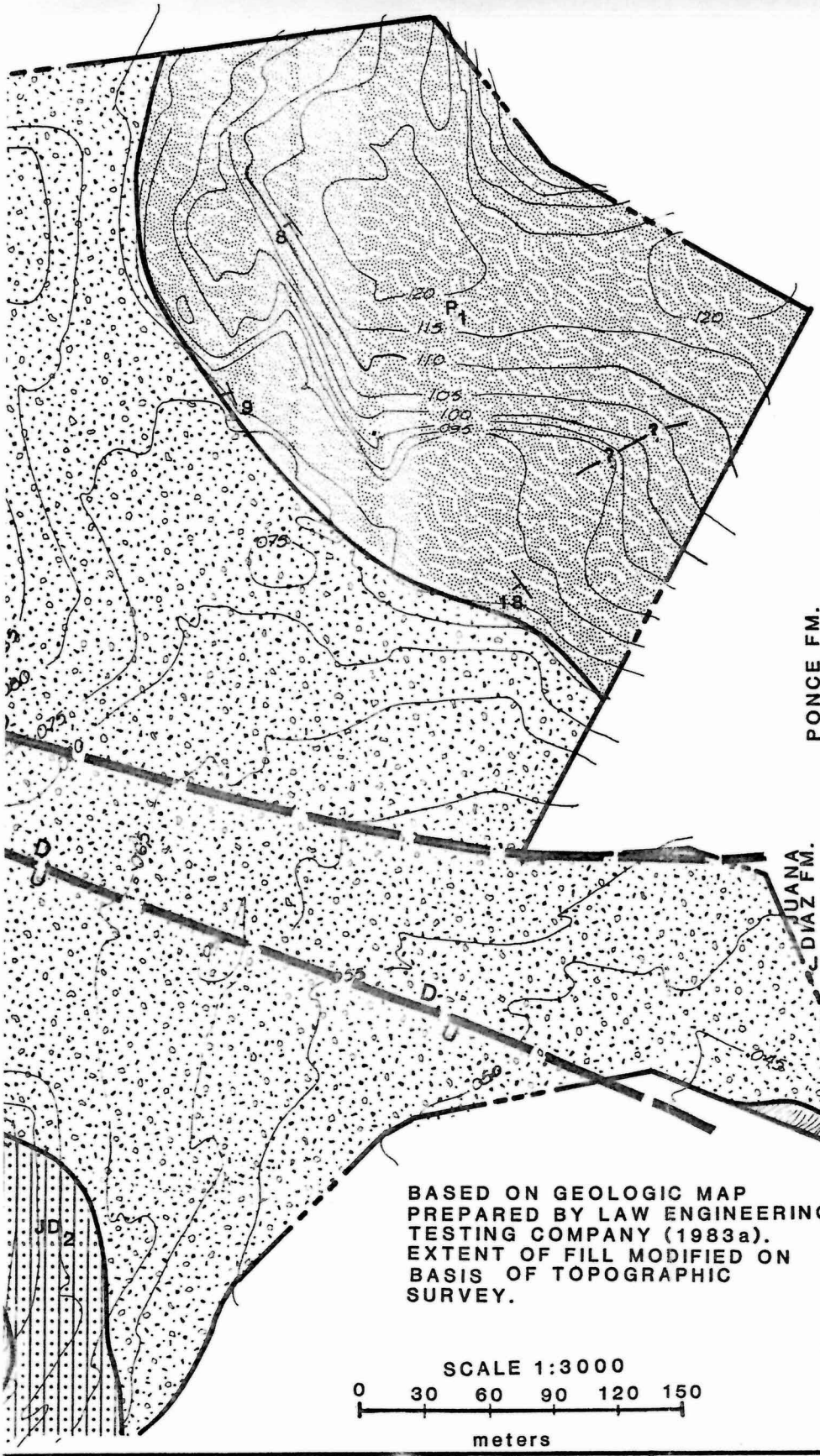
TITLE
REGIONAL GEOLOGIC MAP

DRAWN	CHECKED	REVIEWED	DATE	SCALE	JOB NO.
DRC	SDS		10/12/88	AS SHOWN	883-3643
			FILE NO. 883-3643	DWG. NO. / REV. NO.	FIGURE 3

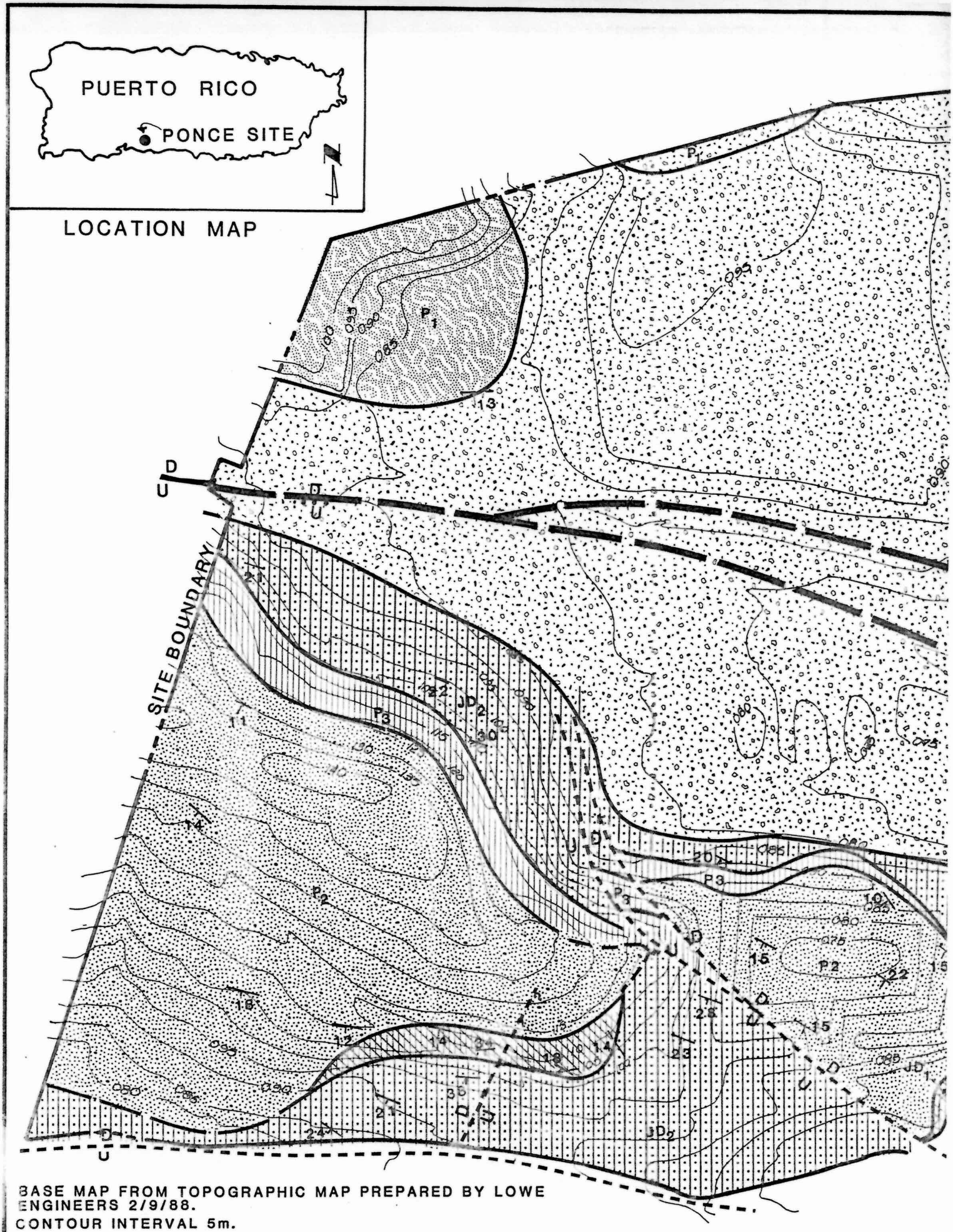
REF:

USGS PROFESSIONAL PAPERS 899, PLATE 1 RESTON, VA.,1976.

3006437

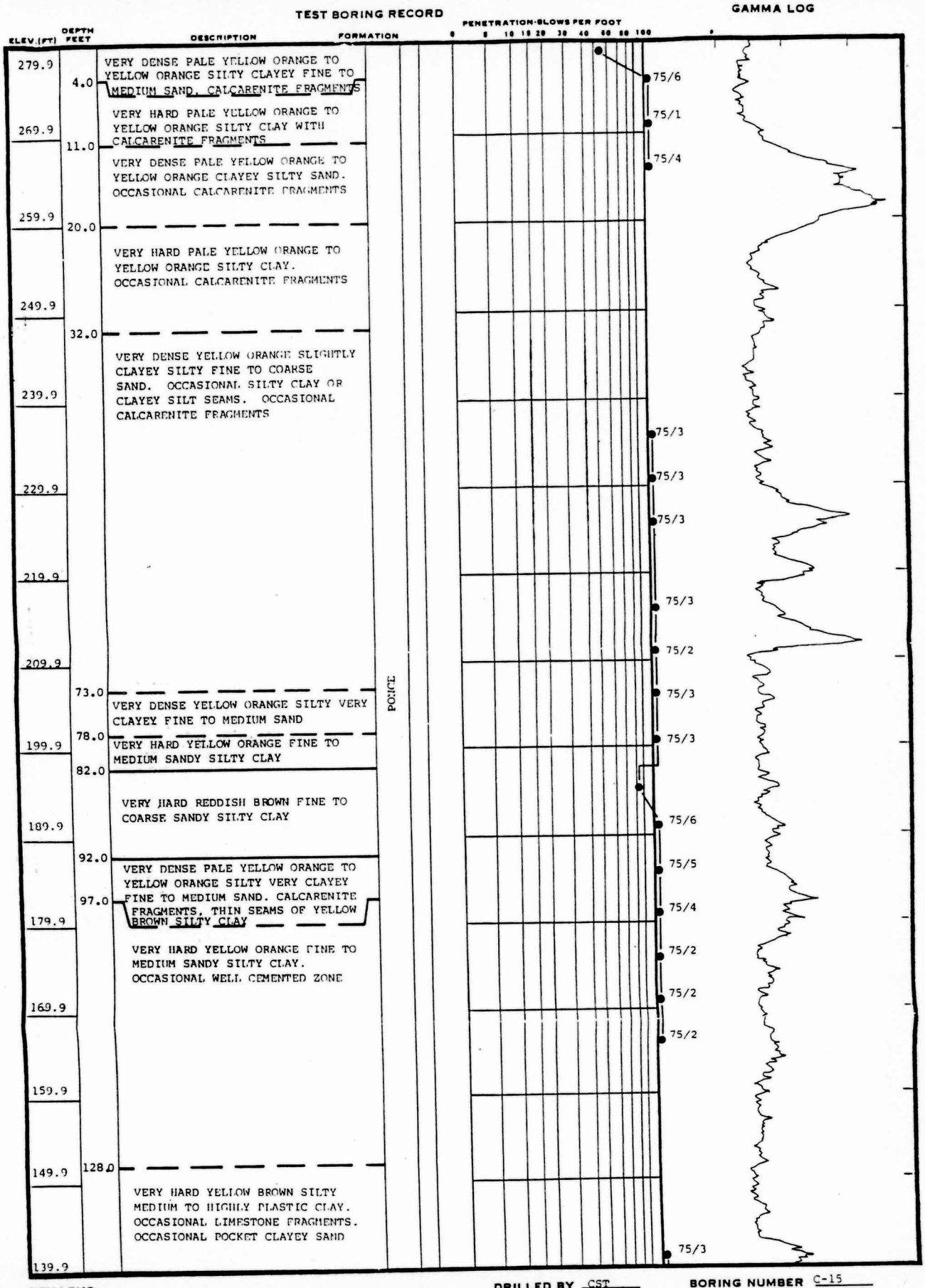


Golder Associates, Inc. Atlanta, Georgia			TITLE: SITE GEOLOGIC MAP		
CLIENT/PROJECT: BFI OF PONCE, INC.			DATE: 6/30/88	SCALE: AS SHOWN	JOB NO.: 883-3643
DRAWN: DRC	CHECKED: CDS	REVIEWED: WRS	FILE NO.: 883-3643	DWG. NO. / REV. NO.: 5	FIGURE: 4



BASE MAP FROM TOPOGRAPHIC MAP PREPARED BY LOWE ENGINEERS 2/9/88.
CONTOUR INTERVAL 5m.
REFERENCE DATUM IS MEAN SEA LEVEL

305301



REMARKS:

SURFACE ELEVATION = 85.3 METERS

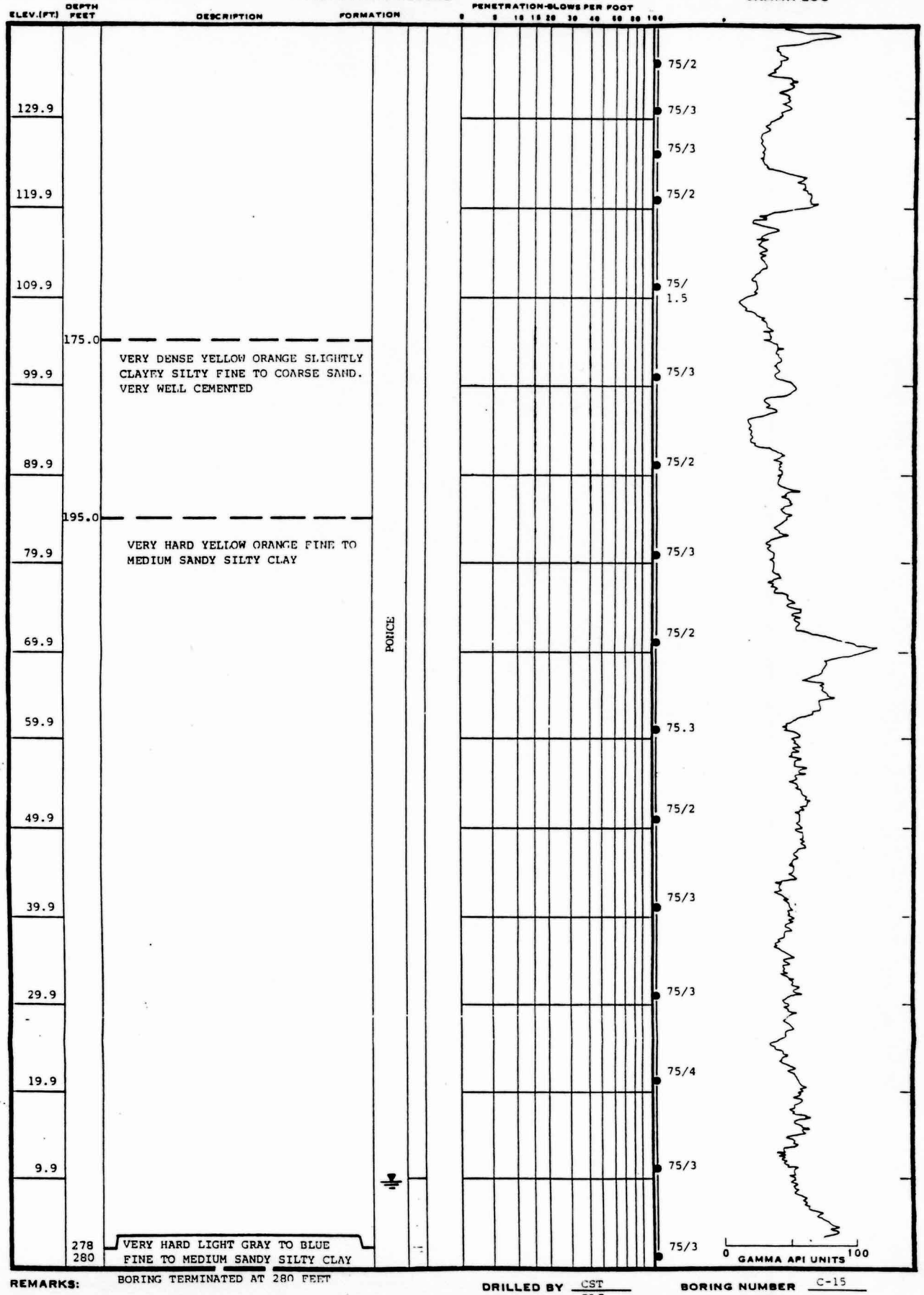
DRILLED BY CST
LOGGED BY BIJ
CHECKED BY LSK

BORING NUMBER C-15
DATE STARTED 1-17-83
DATE COMPLETED 1-25-83
JOB NUMBER GS3233

FIGURE 5

TEST BORING RECORD

GAMMA LOG



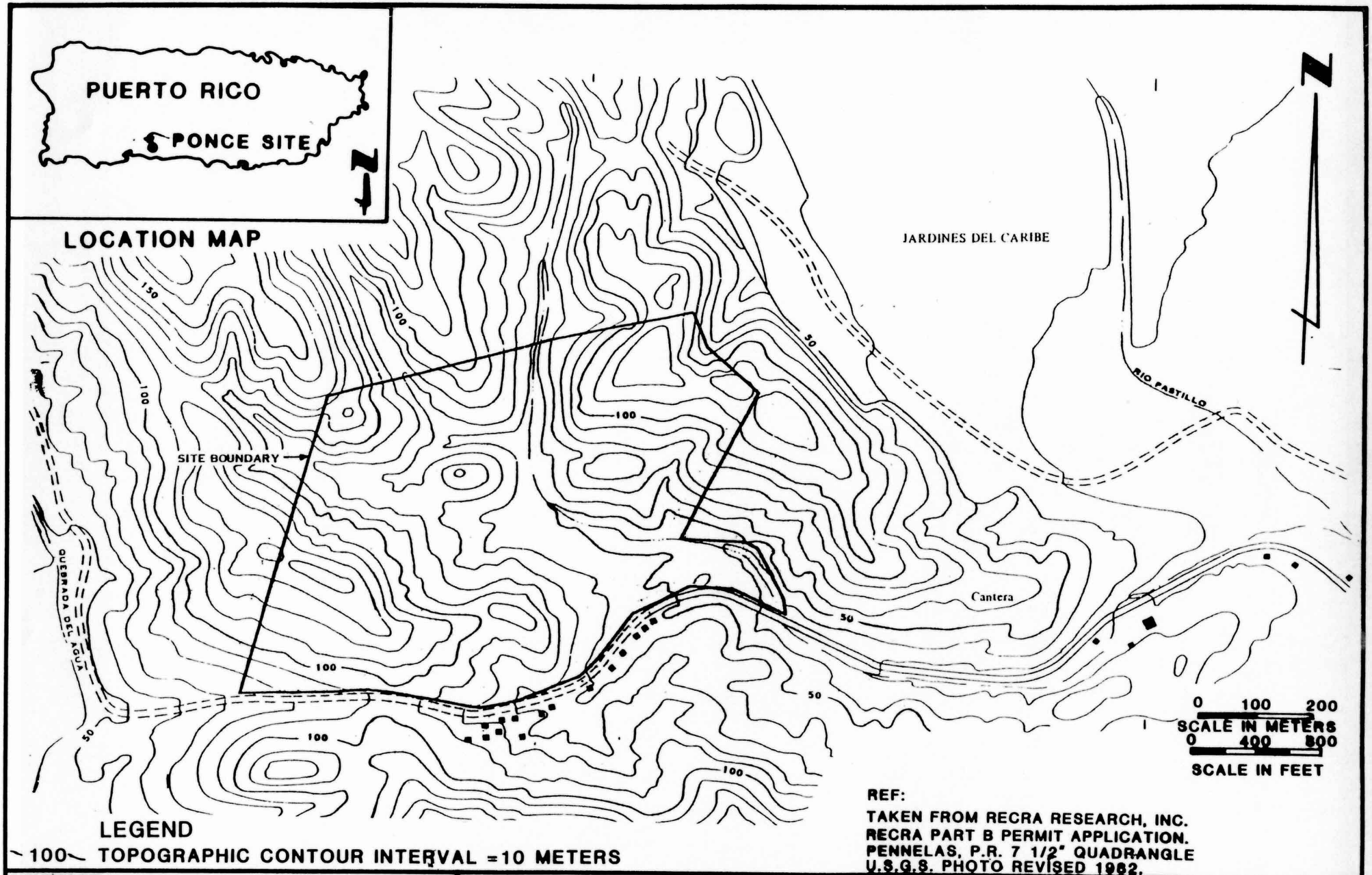
REMARKS: BORING TERMINATED AT 280 FEET

WATER LEVEL 4-13-83

DRILLED BY CST
LOGGED BY BLJ
CHECKED BY LSK

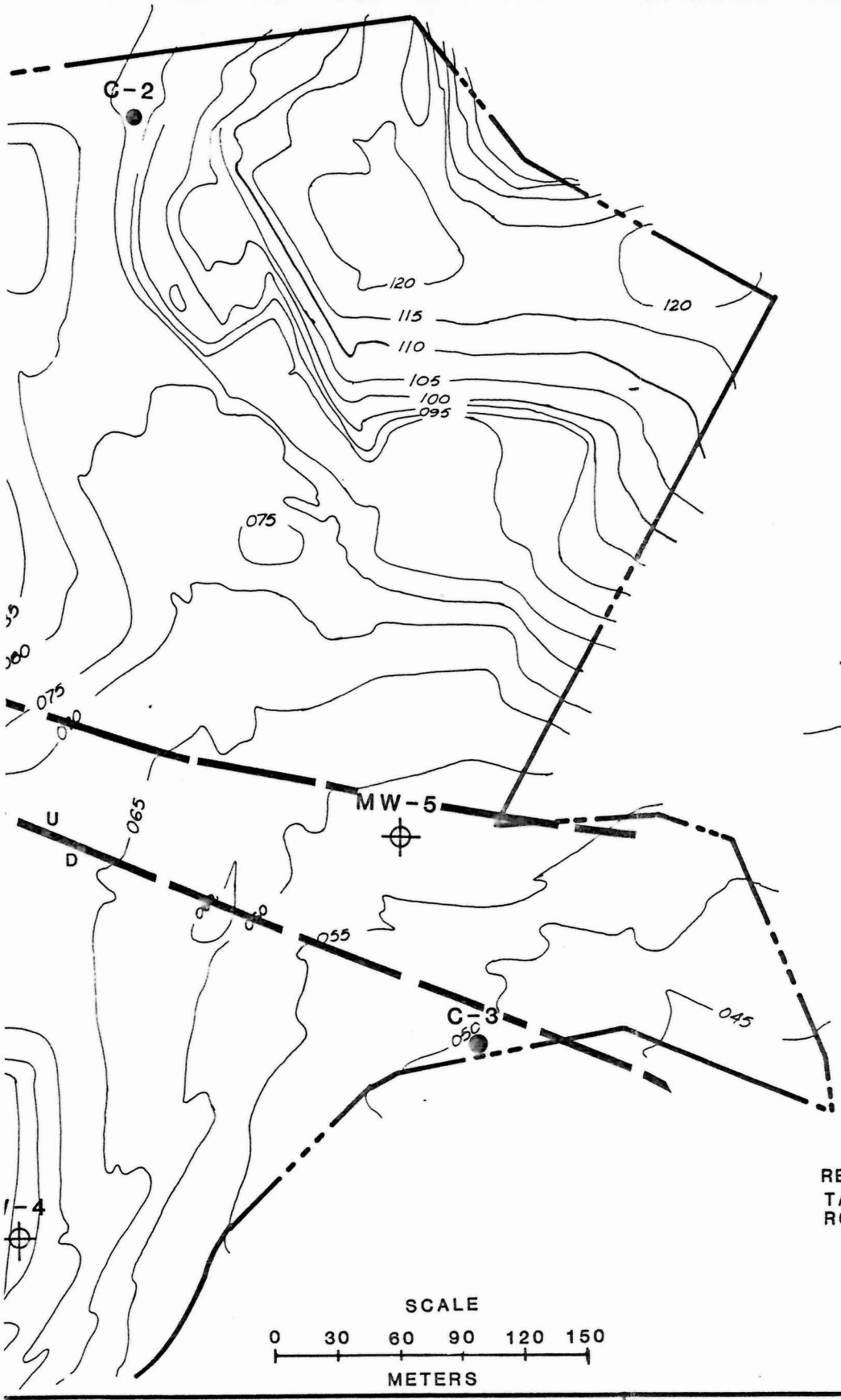
BORING NUMBER C-15
DATE STARTED 3/17/83
DATE COMPLETED 3/25/83
JOB NUMBER GS3223

FIGURE 5



REF:
TAKEN FROM RECRA RESEARCH, INC.
RECRA PART B PERMIT APPLICATION.
PENNELAS, P.R. 7 1/2' QUADRANGLE
U.S.G.S. PHOTO REVISED 1982.

CLIENT/PROJECT				TITLE			
BFI OF PONCE, INC.	Golder Associates Atlanta, Georgia			ORIGINAL SITE TOPOGRAPHY			
DRAWN DRC	CHECKED	REVIEWED	DATE 11/9/88	SCALE AS SHOWN	JOB NO. 883-3643	FILE NO. 883-3643	DWG. NO / REV. NO. 4	FIGURE 6



LEGEND

SITE BOUNDARY

100 TOPOGRAPHIC CONTOUR INTERVAL = 5 METERS

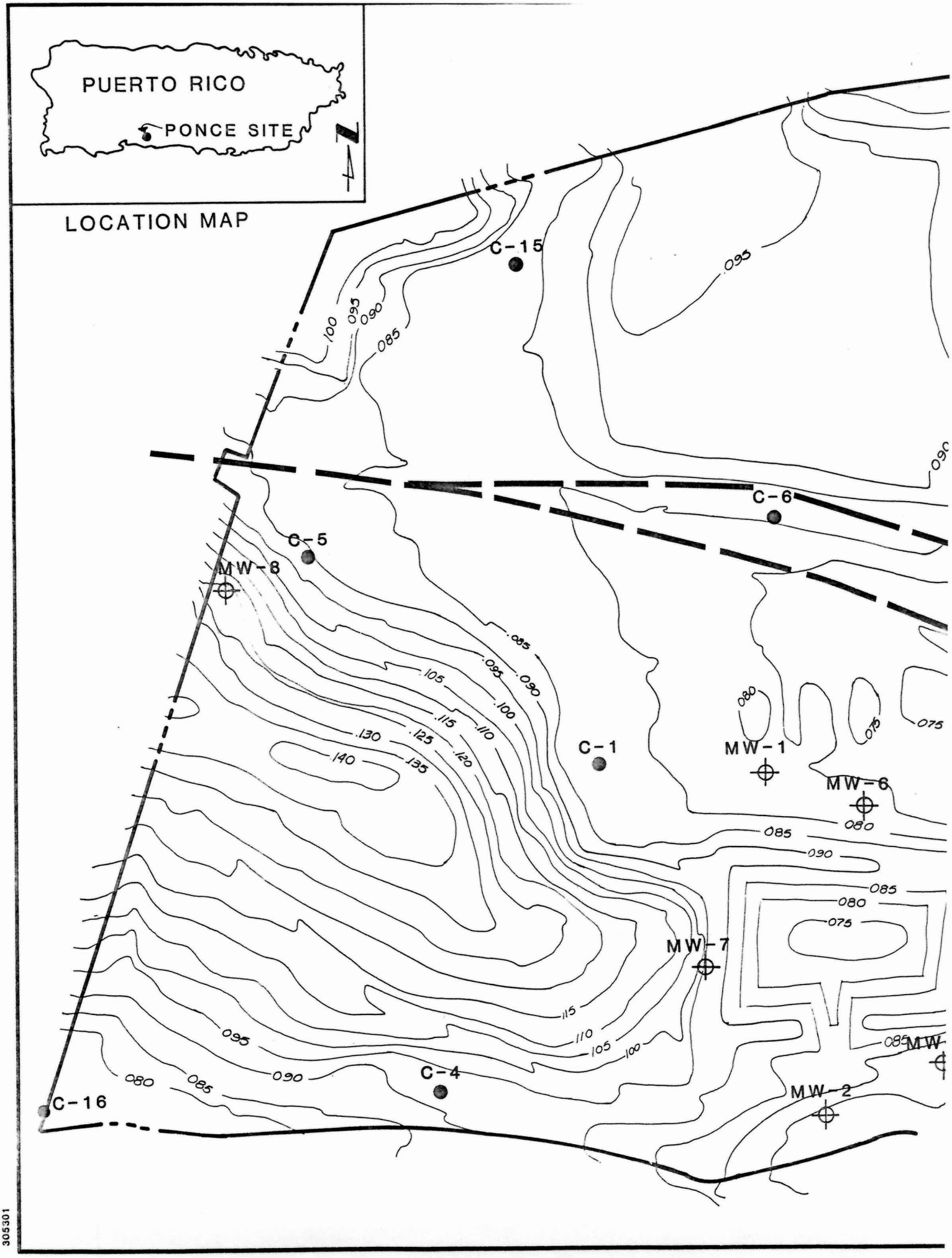
C-2 OBSERVATION WELL (LAW ENGINEERING TESTING CO., 1983a)

MW-3 MONITORING WELL (LAW ENGINEERING TESTING CO., 1983c & 1984d).

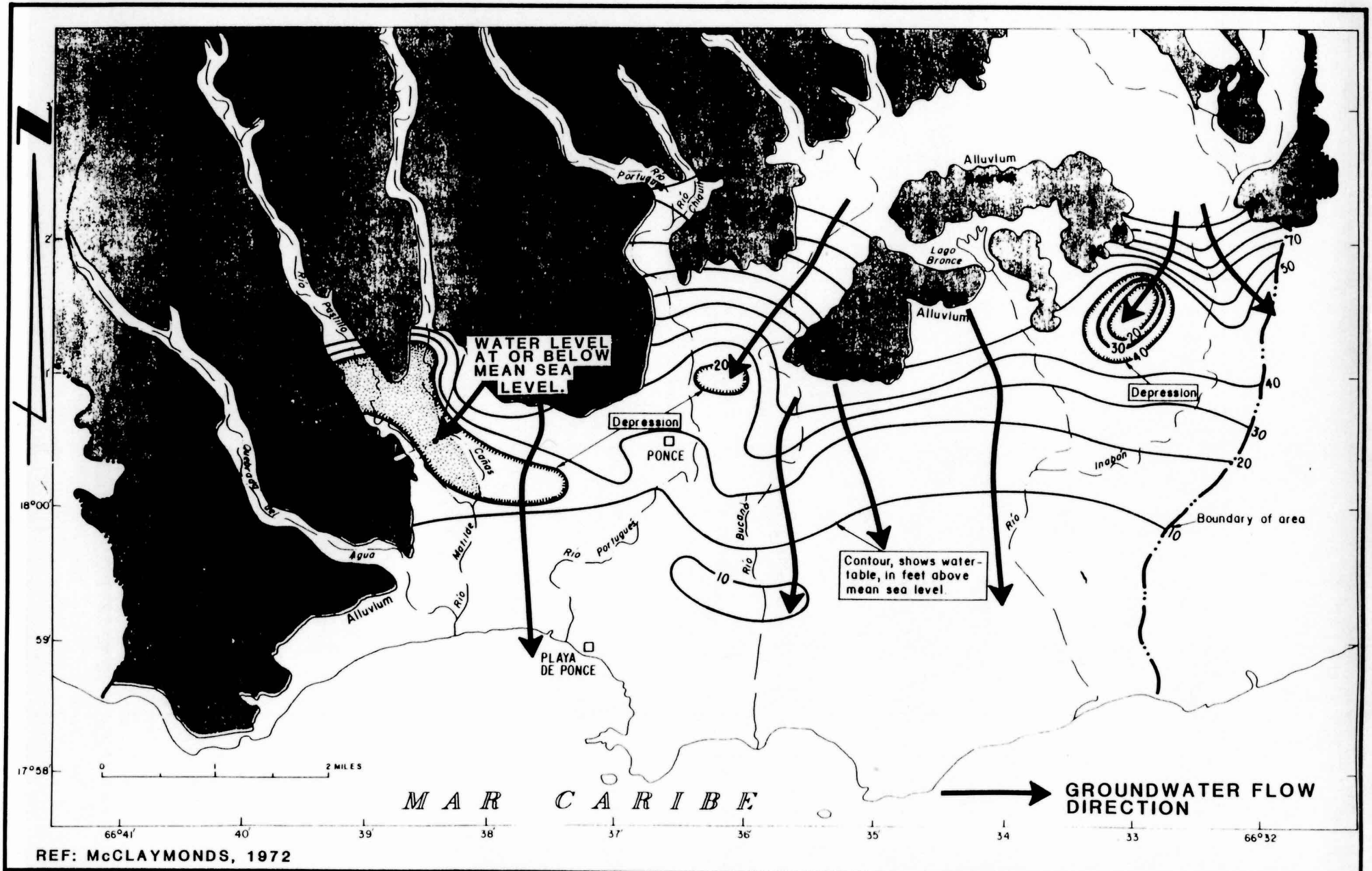
U / D FAULT (U, UPTHROWN SIDE, D, DOWNTHROWN SIDE).

REF:
TAKEN FROM RECRA RESEARCH, INC. RCRA PART B PERMIT APPLICATION.

Golder Associates, Inc. Atlanta, Georgia			TITLE: OBSERVATION AND MONITORING WELLS		
CLIENT/PROJECT: BFI OF PONCE, INC.			DATE: 7/8/88	SCALE: AS SHOWN	JOB NO.: 883-3643
DRAWN: DRC	CHECKED: SDS	REVIEWED: WRS	FILE NO.: 883-3643	DWG. NO. / REV. NO.: 15	FIGURE: 7


PUERTO RICO
PONCE SITE
N
LOCATION MAP
C-15
C-6
C-5
MW-8
C-1
MW-1
MW-6
MW-7
C-4
C-16
MW-2
095
100
090
085
080
075
105
110
115
120
125
130
135
140

305301



REF: McCLAYMONDS, 1972

CLIENT/PROJECT: BFI OF PONCE, INC.	Golder Associates, Inc. Atlanta, Georgia					TITLE: GENERALIZED POTENTIOMETRIC MAP OF THE ALLUVIUM & PONCE FORMATION, OCTOBER-NOVEMBER, 1964		
DRAWN: DRC	CHECKED: SDS	REVIEWED: WRS	DATE: 7/20/88	SCALE: AS SHOWN	JOB NO: 883-3643	FILE NO	DWG NO / REV NO: 17	FIGURE: 8

305301

APPENDIX A

CHEMICAL ANALYSES OF GROUNDWATER DATA

TABLE A-1
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-2

PARAMETERS	UNIT OF MEASURE	MW-2 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
pH	Std. Unit	6.7	6.7	7.92	-
Specific Conductance	MHOS/CM	7,200	5,800	4,775	-
Chloride	mg/l	1,940	1,840	1,620	1,650
Fluoride	mg/l	1.56	1.16	1.20	1.26
Nitrate	mg/g N/l	-	14.4	-	15
Sulfate	mg/l	1,760	1,540	500	2.0
Total Organic Carbon	mg/l	2.9	7.9	42	9
Total Organic Halide	ug/l	87	90	53	72
T-Recoverable Phenolics	mg/l	<0.01	<0.01	<0.01	<0.01
T-Soluble Aluminum	mg/l	0.35	<0.20	7.2	0.41
T-Soluble Antimony	mg/l	0.033	<0.01	<0.01	0.005
T-Soluble Barium	mg/l	0.37	1.29	0.70	0.17
T-Soluble Cadmium	mg/l	0.018	<0.007	<0.02	<0.007
T-Soluble Calcium	mg/l	391	452	305	0.12
T-Soluble Chromium	mg/l	<0.006	<0.004	-	<0.008
T-Soluble Copper	mg/l	<0.006	0.044	0.106	0.02
T-Soluble Iron	mg/l	0.55	0.27	19.2	<0.04
T-Soluble Lead	mg/l	<0.005	<0.005	-	0.02
T-Soluble Magnesium	mg/l	560	235	193	190
T-Soluble Manganese	mg/l	0.02	<0.01	0.49	0.04
T-Soluble Nickel	mg/l	0.035	0.037	0.010	0.01
T-Soluble Potassium	mg/l	13	14	13.5	11

TABLE A-1
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-2

PARAMETERS	UNIT OF MEASURE	MW-2 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
T-Soluble Silver	mg/l	0.009	<0.005	-	<0.009
T-Soluble Sodium	mg/l	1,150	1,030	1,300	770
T-Soluble Thallium	mg/l	0.012	<0.01	<0.01	<0.005
T-Soluble Tin	mg/l	<0.01	<0.5	<0.5	2.7
T-Soluble Vanadium	mg/l	2.8	2.2	<0.10	<0.12
T-Soluble Zinc	mg/l	0.027	0.254	0.193	0.14
Gross Alpha Radiation	pCi/l	6 +/- 5	<2	18 +/- 12	<2
Gross Beta Radiation	pCi/l	14 +/- 3	18 +/- 7	26 +/- 6	9 +/-
Total Radium	pCi/l	7 +/- 2	<1	5 +/- 1	<1
Aldrin	ug/l	0.03	-	<0.01	<0.01
Alpha -BHC	ug/l	<0.01	-	<0.01	<0.01
Beta -BHC	ug/l	<0.01	-	<0.01	<0.01
Delta -BHC	ug/l	0.44	-	0.01	<0.01
Gamma -BHC	ug/l	0.04	-	<0.01	<0.01
Dieldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -Endosulfan	ug/l	0.08	-	<0.01	<0.01
Trans-1,2-Dichloroethylene*	ug/l	ND	-	-	-

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-2
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-3

PARAMETERS	UNIT OF MEASURE	MW-3 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
pH	Std. Unit	6.5	6.4	7.6	-
Specific Conductance	MHOS/CM	13,900	9,700	10,375	-
Chloride	mg/l	3,860	4,030	3,950	3,830
Fluoride	mg/l	0.33	0.47	0.31	0.27
Nitrate	mg/g N/l	-	1.43	1.2	1.1
Sulfate	mg/l	1,890	2,350	2,020	19
Total Organic Carbon	mg/l	22	4.1	33	6
Total Organic Halide	ug/l	140	2,600	66	72
T-Recoverable Phenolics	mg/l	<0.01	0.029	<0.01	<0.01
T-Soluble Aluminum	mg/l	0.25	<0.02	2.3	0.33
T-Soluble Antimony	mg/l	0.028	<0.01	0.023	-
T-Soluble Barium	mg/l	0.35	0.55	1.90	0.14
T-Soluble Cadmium	mg/l	0.029	0.014	<0.02	-
T-Soluble Calcium	mg/l	571	798	750	<0.01
T-Soluble Chromium	mg/l	0.008	<0.004	0.028	<0.008
T-Soluble Copper	mg/l	<0.01	0.068	0.037	-
T-Soluble Iron	mg/l	1.8	0.40	3.30	0.74
T-Soluble Lead	mg/l	<0.005	<0.005	<0.002	0.01
T-Soluble Magnesium	mg/l	855	740	935	1,200
T-Soluble Manganese	mg/l	0.23	0.23	0.26	0.14
T-Soluble Nickel	mg/l	0.042	0.041	0.032	-
T-Soluble Potassium	mg/l	50	61	75	68

TABLE A-2
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-3

PARAMETERS	UNIT OF MEASURE	MW-3 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
T-Soluble Silver	mg/l	<0.008	0.008	0.040	<0.009
T-Soluble Sodium	mg/l	1,740	1,510	1.920	1,400
T-Soluble Thallium	mg/l	0.021	<0.01	0.013	-
T-Soluble Tin	mg/l	<0.01	<0.5	<0.5	2.5
T-Soluble Vanadium	mg/l	4.1	3.6	<0.1	<0.12
T-Soluble Zinc	mg/l	0.182	0.628	0.129	-
Gross Alpha Radiation	pCi/l	9 +/- 8	<2	5 +/- 4	<2
Gross Beta Radiation	pCi/l	15 +/- 3	28 +/- 4	16 +/- 3	13 +/- 3
Total Radium	pCi/l	<1	<1	2 +/- 1	2 +/- 1
Aldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -BHC	ug/l	<0.01	-	<0.01	<0.01
Beta -BHC	ug/l	<0.01	-	<0.01	<0.01
Delta -BHC	ug/l	0.03	-	<0.01	<0.01
Gamma -BHC	ug/l	<0.01	-	<0.01	<0.01
Dieldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -Endosulfan	ug/l	<0.01	-	<0.01	<0.01
Trans-1,2-Dichloroethylene*	ug/l	ND	-	<0.01	-

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-3
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-4

PARAMETERS	UNIT OF MEASURE	MW-4 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984
pH	Std. Unit	6.5	6.4	6.64
Specific Conductance	MHOS/CM	10,000	8,300	9,325
Chloride	mg/l	3,320	3,620	3,670
Fluoride	mg/l	0.34	0.39	0.25
Nitrate	mg/g N/l	-	1.69	1.70
Sulfate	mg/l	841	1,560	1,400
Total Organic Carbon	mg/l	6.6	4.9	31
Total Organic Halide	ug/l	90	2,025	84
T-Recoverable Phenolics	mg/l	<0.01	<0.01	0.015
T-Soluble Aluminum	mg/l	<0.06	<0.2	2.4
T-Soluble Antimony	mg/l	0.013	<0.01	0.044
T-Soluble Barium	mg/l	0.36	0.59	2.40
T-Soluble Cadmium	mg/l	0.020	<0.007	<0.02
T-Soluble Calcium	mg/l	556	971	821
T-Soluble Chromium	mg/l	0.008	0.014	0.021
T-Soluble Copper	mg/l	<0.01	0.110	0.054
T-Soluble Iron	mg/l	0.12	<0.03	6.20
T-Soluble Lead	mg/l	<0.005	<0.005	0.011
T-Soluble Magnesium	mg/l	735	530	830
T-Soluble Manganese	mg/l	0.04	0.17	0.24
T-Soluble Nickel	mg/l	0.009	0.024	0.015
T-Soluble Potassium	mg/l	30	62	73

TABLE A-3
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-4

PARAMETERS	UNIT OF MEASURE	MW-4 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
T-Soluble Silver	mg/l	<0.008	0.007	0.047	<0.009
T-Soluble Sodium	mg/l	980	1,050	1,330	1,000
T-Soluble Thallium	mg/l	0.019	<0.01	0.014	-
T-Soluble Tin	mg/l	<0.1	-	<0.5	-
T-Soluble Vanadium	mg/l	3.7	4.1	<0.1	<0.12
T-Soluble Zinc	mg/l	0.027	0.626	0.131	-
Gross Alpha Radiation	pCi/l	5 +/- 4	4 +/- 2	<2	<2
Gross Beta Radiation	pCi/l	17 +/- 3	30 +/- 8	15 +/- 3	18 +/- 3
Total Radium	pCi/l	<1	4 +/- 2	<1	<1
Aldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -BHC	ug/l	<0.01	-	<0.01	<0.01
Beta -BHC	ug/l	<0.01	-	<0.01	<0.01
Delta -BHC	ug/l	<0.01	-	<0.01	<0.01
Gamma -BHC	ug/l	<0.01	-	<0.01	<0.01
Dieldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -Endosulfan	ug/l	0.99	-	<0.01	<0.01
Trans-1,2-Dichloroethylene*	ug/l	ND	-	-	-

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-4
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-5

PARAMETERS	UNIT OF MEASURE	MW-5 (Date) NOVEMBER 1983	JANUARY 1984	MARCH 1984
pH	Std. Unit	6.65	6.7	-
Specific Conductance	MHOS/CM	23,800	13,200	-
Chloride	mg/l	8,000	8,510	8,560
Fluoride	mg/l	0.84	0.64	0.62
Nitrate	mg/g N/l	-	0.31	<1
Sulfate	mg/l	145	1,860	14
Total Organic Carbon	mg/l	85	78	94
Total Organic Halide	ug/l	58	1,600	902.5
T-Recoverable Phenolics	mg/l	<0.1	0.029	0.010
T-Soluble Aluminum	mg/l	0.22	<0.2	0.45
T-Soluble Antimony	mg/l	0.033	<0.01	0.007
T-Soluble Barium	mg/l	0.59	1.46	0.50
T-Soluble Cadmium	mg/l	0.039	<0.007	<0.005
T-Soluble Calcium	mg/l	819	1,040	<0.007
T-Soluble Chromium	mg/l	0.014	0.004	<0.008
T-Soluble Copper	mg/l	0.056	0.064	0.03
T-Soluble Iron	mg/l	1.2	<0.03	1.1
T-Soluble Lead	mg/l	<0.001	<0.001	0.11
T-Soluble Magnesium	mg/l	840	530	650
T-Soluble Manganese	mg/l	2.3	2.6	6.1
T-Soluble Nickel	mg/l	0.089	0.139	0.30
T-Soluble Potassium	mg/l	141	136	190

TABLE A-4
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-5

PARAMETERS	UNIT OF MEASURE	MW-5 (Date) NOVEMBER 1983	JANUARY 1984	MARCH 1984
T-Soluble Silver	mg/l	<0.008	0.023	<0.009
T-Soluble Sodium	mg/l	4,650	3,500	4,600
T-Soluble Thallium	mg/l	0.028	<0.01	0.006
T-Soluble Tin	mg/l	<0.1	<0.1	7.0
T-Soluble Vanadium	mg/l	5.8	5.6	<0.12
T-Soluble Zinc	mg/l	0.238	0.394	0.11
Gross Alpha Radiation	pCi/l	23 +/- 20	<2	<2
Gross Beta Radiation	pCi/l	4 +/- 2	7319	25 +/- 3
Total Radium	pCi/l	4 +/- 2	<1	<1
Aldrin	ug/l	0.05	<0.1	<0.1
Alpha -BHC	ug/l	0.30	<0.1	<0.1
Beta -BHC	ug/l	0.37	<0.1	<0.1
Delta -BHC	ug/l	0.17	31	<0.1
Gamma -BHC	ug/l	0.08	<0.1	<0.1
Dieldrin	ug/l	0.59	<0.1	<0.1
Alpha -Endosulfan	ug/l	0.11	<0.1	<0.1
Trans-1,2-Dichloroethylene*	ug/l	22	22	25

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-5
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-6

PARAMETERS	UNIT OF MEASURE	MW-6 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984
pH	Std. Unit	-	-	7.55
Specific Conductance	MHOS/CM	-	-	5,200
Chloride	mg/l	-	-	1,690
Fluoride	mg/l	-	-	0.18
Nitrate	mg/g N/l	-	-	2.3
Sulfate	mg/l	-	-	680
Total Organic Carbon	mg/l	-	-	24.5
Total Organic Halide	ug/l	-	-	75
T-Recoverable Phenolics	mg/l	-	-	<0.01
T-Soluble Aluminum	mg/l	-	-	9.7
T-Soluble Antimony	mg/l	-	-	<0.01
T-Soluble Barium	mg/l	-	-	1.45
T-Soluble Cadmium	mg/l	-	-	<0.02
T-Soluble Calcium	mg/l	-	-	411
T-Soluble Chromium	mg/l	-	-	0.042
T-Soluble Copper	mg/l	-	-	0.114
T-Soluble Iron	mg/l	-	-	28.0
T-Soluble Lead	mg/l	-	-	0.006
T-Soluble Magnesium	mg/l	-	-	228
T-Soluble Manganese	mg/l	-	-	0.73
T-Soluble Nickel	mg/l	-	-	0.057
T-Soluble Potassium	mg/l	-	-	24.4

TABLE A-5

(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-6

PARAMETERS	UNIT OF MEASURE	MW-6 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984
T-Soluble Silver	mg/l	-	-	0.032
T-Soluble Sodium	mg/l	-	-	980
T-Soluble Thallium	mg/l	-	-	<0.01
T-Soluble Tin	mg/l	-	-	<0.05
T-Soluble Vanadium	mg/l	-	-	<0.01
T-Soluble Zinc	mg/l	-	-	0.786
Gross Alpha Radiation	pCi/l	-	-	14 +/- 12
Gross Beta Radiation	pCi/l	-	-	38 +/- 7
Total Radium	pCi/l	-	-	14 +/- 2
Aldrin	ug/l	-	-	<0.01
Alpha -BHC	ug/l	-	-	<0.01
Beta -BHC	ug/l	-	-	<0.01
Delta -B**	ug/l	-	-	<0.01
Gamma -BHC	ug/l	-	-	<0.01
Dieldrin	ug/l	-	-	<0.01
Alpha -Endosulfan	ug/l	-	-	<0.01
Trans-1,2-Dichloroethylene*	ug/l	-	-	ND

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-6
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-7

PARAMETERS	UNIT OF MEASURE	MW-5 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
pH	Std. Unit	-	8.95	7.83	-
Specific Conductance	MHOS/CM	-	3,900	491	-
Chloride	mg/l	-	892	1,420	1,590
Fluoride	mg/l	-	0.13	-	0.30
Nitrate	mg/g N/l	-	0.12	21	0.06
Sulfate	mg/l	-	970	960	8.9
Total Organic Carbon	mg/l	-	3	8	3
Total Organic Halide	ug/l	-	200	12	28
T-Recoverable Phenolics	mg/l	-	0.026	0.016	<0.01
T-Soluble Aluminum	mg/l	-	<0.2	-	0.43
T-Soluble Antimony	mg/l	-	<0.01	0.010	<0.005
T-Soluble Barium	mg/l	-	0.39	-	0.24
T-Soluble Cadmium	mg/l	-	<0.007	<0.02	<0.007
T-Soluble Calcium	mg/l	-	67.3	-	<0.01
T-Soluble Chromium	mg/l	-	<0.004	0.011	<0.008
T-Soluble Copper	mg/l	-	0.006	0.015	0.02
T-Soluble Iron	mg/l	-	<0.03	9.3	4.1
T-Soluble Lead	mg/l	-	<0.005	<0.002	0.03
T-Soluble Magnesium	mg/l	-	170	-	300
T-Soluble Manganese	mg/l	-	0.01	1.12	1.6
T-Soluble Nickel	mg/l	-	<0.005	0.008	0.006
T-Soluble Potassium	mg/l	-	40	-	57

TABLE A-6
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-7

PARAMETERS	UNIT OF MEASURE	MW-5 (Date) NOVEMBER 1983	JANUARY 1984	FEBRUARY 1984	MARCH 1984
T-Soluble Silver	mg/l	-	<0.005	<0.01	<0.009
T-Soluble Sodium	mg/l	-	640	1,170	87
T-Soluble Thallium	mg/l	-	<0.01	<0.01	<0.005
T-Soluble Tin	mg/l	-	<0.5	-	<0.5
T-Soluble Vanadium	mg/l	-	0.54	-	<0.12
T-Soluble Zinc	mg/l	-	0.200	1.75	0.03
Gross Alpha Radiation	pCi/l	-	<2	18 +/- 11	<2
Gross Beta Radiation	pCi/l	-	19 +/- 7	12 +/- 3	16 +/- 3
Total Radium	pCi/l	-	3 +/- 2	<1	<1
Aldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -BHC	ug/l	<0.01	-	<0.01	<0.01
Beta -BHC	ug/l	<0.01	-	<0.01	<0.01
Delta -BHC	ug/l	2.3	-	<0.01	<0.01
Gamma -BH	ug/l	<0.01	-	<0.01	<0.01
Dieldrin	ug/l	<0.01	-	<0.01	<0.01
Alpha -Endosulfan	ug/l	0.05	-	<0.01	<0.01
Trans-1,2-Dichloroethylene*	ug/l	ND	-	ND	ND

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-7
(Page 1 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-8

PARAMETERS	UNIT OF MEASURE	MW-8 (Date) NOVEMBER 1983	DECEMBER 1983	MARCH 1984
pH	Std. Unit	-	-	-
Specific Conductance	MHOS/CM	-	-	-
Chloride	mg/l	-	-	1,100
Fluoride	mg/l	-	-	0.50
Nitrate	mg/g N/l	-	-	0.90
Sulfate	mg/l	-	-	4.5
Total Organic Carbon	mg/l	-	-	4
Total Organic Halide	ug/l	-	-	23
T-Recoverable Phenolics	mg/l	-	-	<0.01
T-Soluble Aluminum	mg/l	-	-	0.35
T-Soluble Antimony	mg/l	-	-	-
T-Soluble Barium	mg/l	-	-	0.11
T-Soluble Cadmium	mg/l	-	-	-
T-Soluble Calcium	mg/l	-	-	<0.01
T-Soluble Chromium	mg/l	-	-	0.02
T-Soluble Copper	mg/l	-	-	-
T-Soluble Iron	mg/l	-	-	<0.04
T-Soluble Lead	mg/l	-	-	0.04
T-Soluble Magnesium	mg/l	-	-	26
T-Soluble Manganese	mg/l	-	-	0.02
T-Soluble Nickel	mg/l	-	-	-
T-Soluble Potassium	mg/l	-	-	21

TABLE A-7
(Page 2 of 2)

SUMMARY OF ANALYTICAL RESULTS
FOR GROUNDWATER MONITORING
WELL-MW-8

PARAMETERS	UNIT OF MEASURE	MW-8 (Date) NOVEMBER 1983	DECEMBER 1983	MARCH 1984
T-Soluble Silver	mg/l	-	-	<0.009
T-Soluble Sodium	mg/l	-	-	94
T-Soluble Thallium	mg/l	-	-	-
T-Soluble Tin	mg/l	-	-	<0.5
T-Soluble Vanadium	mg/l	-	-	<0.12
T-Soluble Zinc	mg/l	-	-	-
Gross Alpha Radiation	pCi/l	-	-	12 +/- 10
Gross Beta Radiation	pCi/l	-	-	9 +/- 3
Total Radium	pCi/l	-	-	<1
Aldrin	ug/l	-	-	<0.01
Alpha -BHC	ug/l	-	-	<0.01
Beta -BHC	ug/l	-	-	<0.01
Delta -BHC	ug/l	-	-	<0.01
Gamma -BHC	ug/l	-	-	<0.01
Dieldrin	ug/l	-	-	<0.01
Alpha -Endosulfan-	ug/l	-	-	<0.01
Trans-1,2-Dichloroethylene*	ug/l	-	-	ND

* Detection limit for compound is 1.6 ug/l.

ND - Not Detected

TABLE A-8

SUMMARY ANALYTICAL RESULTS FOR LANDFILL COMPOSITES

Parameter	Unit of Measure	SAMPLE IDENTIFICATION Comp-CD-2	Comp-CD-4	Comp-CD-6	Comp-CD-8	Comp-CD-9	Comp-CD-10	Comp-CD-11	Comp-CD-12	Comp-CD-13	Comp-CD-14	Comp-CD-15	Comp-CD-16
Chemical Oxygen Demand	ug/g Dry	5,700	7,800	9,000	21,500	55,300	27,100	53,300	17,100	163,000	12,800	24,700	4,010
Total Recoverable Phenolics	ug/g Dry	2.27	2.03		0.82			1.15	2.09	2.89			
Total Recoverable Oil & Grease	ug/g Dry	2,280	330	1,400	21,000	3,300	2,280	7,090	1,740	8,330	33,700	18,800	54,400
Total Cyanide	ug/g Dry		0.76	0.72	1.97	2.28				0.93	0.77	1.43	1.22
Total Barium	ug/g Dry	76	110	204	228	120	133	244	153	113	45		250
Total Zinc	ug/g Dry	34	204	24	46	149	50	72	84	52	24	42	4.7
Halogenated Organic Scan (ECD)	*		0.76		0.10	0.10				0.23			
Total Poly-chlorinated Biphenyls	**		0.17 0.34 0.41										

* ug/g dry as Chlorine; Lindane Standard

** ug/g dry as Aroclor 1242
ug/g dry as Aroclor 1260
ug/g dry Total

TABLE A-9

SUMMARY OF ANALYTICAL RESULTS
FOR THE
ROADWAY SIDEWALL COMPOSITES

Parameter	Unit of Measure	SAMPLE IDENTIFICATION								
		COMP-RW 1	COMP-RW 2	COMP-RW 3	COMP-RW 4	COMP-RW 5	COMP-RW 6	COMP-RW 7	COMP-RW 8	COMP-RW 9
Total Cyanide	ug/g Dry	1.5	2.0	--	13	33	1.2	0.51	0.63	--
Leachable Organic Carbon	ug/g Dry	490	830	420	1,300	2,500	470	810	380	400
Leachable Sulfide	ug/g Dry	36	400	180	1,370	1,330	140	51	210	1,200
Halogenated Organic Scan (ECD)	ug/g Dry As Chlor. Lindane Std.	0.1	0.20	0.13	1.0	23	0.12	--	0.13	0.55
EP Toxicity Test Extracts										
Total Arsenic	mg/l	0.043	0.110	0.043	0.036	0.029	0.033	0.029	0.033	0.026
Total Barium	mg/l	1.3	1.1	1.4	1.0	1.3	1.2	1.3	1.1	1.3
Total Cadium	mg/l	0.009	--	--	--	--	--	--	--	--
Total Chromium	mg/l	0.036	0.026	0.053	--	--	0.023	--	0.060	0.028
Total Lead	mg/l	0.095	0.064	0.100	0.036	0.088	0.023	--	0.033	0.100

APPENDIX B

OBSERVATION AND MONITORING WELLS

WATER LEVEL READINGS

Piezometer C-1
Ground Surface Elevation (M.P.) 268.7 ft.; 81.9 m
Top of Casing Elevation (M.P.) 271.5 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
2-25-83	Ground Surface	63.0	205.7
3-31-83	Ground Surface	70.3	198.4
4-4-83	Ground Surface	72.8	195.9
4-8-83	Ground Surface	72.0	196.7
4-12-83	Top of Casing	76.3	195.2
4-13-83	Top of Casing	76.4	195.1
5-25-83	Top of Casing, Water Level Difficult to Determine	71.9	199.6
7-21-83	Top of Casing, Water Level Difficult to Determine	86	185.5
8-20-83	Top of Casing, Water Level Difficult to Determine	81.83	189.67
8-25-83	Top of Casing, Water Level Difficult to Determine	81.9	189.60
9-1-83	Top of Casing Water Level Easy to Read	81.9	189.6
7-15-88	Top of Casing	70.11	201.39

WATER LEVEL READINGS

Piezometer C-3
Ground Surface Elevation (M.P.) 160.1 ft.; 48.8 m
Top of Casing Elevation (M.P.) 163.3 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-1-83	Ground Surface	52.6	107.5
3-9-83	Ground Surface	52.5	107.6
3-31-83	Ground Surface	72.5	87.6
4-4-83	Ground Surface	78.5	81.6
4-8-83	Ground Surface	73.0	87.1
4-12-83	Top of Casing	77.1	86.2
4-13-83	Top of Casing	77.0	86.3
5-25-83	Top of Casing	77.18	86.12
7-21-83	Top of Casing	77.40	85.9
8-20-83	Top of Casing	76.91	86.39
8-25-83	Top of Casing	77.0	86.3
9-1-83	Top of Casing	76.9	86.4
7-15-88	Top of Casing, Could not get water level probe past 25 ft.	---	---

WATER LEVEL READINGS

Piezometer C-4
Ground Surface Elevation (M.P.) 294.9 ft.; 89.87 m
Top of Casing Elevation (M.P.) 297.0 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-8-83	Ground Surface	154.5	140.4
3-10-83	Ground Surface	150.4	144.5
3-22-83	Ground Surface	149.5	145.4
3-28-83	Ground Surface	149.5	145.4
4-4-83	Ground Surface	138.0	156.9
4-8-83	Ground Surface	149.6	145.3
4-12-83	Top of Casing	151.4	145.6
4-13-83	Top of Casing	151.5	145.5
5-25-83	Top of Casing	150.8	146.2
8-20-83	Top of Casing	149.8	147.2
8-25-83	Top of Casing	149.8	147.2
9-1-83	Top of Casing	149.8	147.2
7-15-88	Top of Casing	137.03	159.97

WATER LEVEL READINGS

Piezometer C-5
Ground Surface Elevation (M.P.) 288.4 ft.; 87.9 m
Top of Casing Elevation (M.P.) 291.2 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-11-83	Ground Surface	72.5	215.9
3-22-83	Ground Surface	78.0	210.4
3-28-83	Ground Surface	78.5	209.9
4-4-83	Ground Surface	84.7	203.9
4-8-83	Ground Surface	85.7	202.7
4-12-83	Top of Casing	87.4	203.8
4-13-83	Top of Casing	89.5	201.7
5-25-83	Top of Casing, Water Level Difficult to Determine	78.27	212.93
7-21-83	Top of Casing, Water Level Difficult to Determine	97.3	193.9
8-20-83	Top of Casing, Water Level Difficult to Determine	101.52	189.68
8-25-83	Top of Casing, Water Level Difficult to Determine	100.1	191.1
9-1-83	Top of Casing Water Level Difficult to Read	100.2	191.0

WATER LEVEL READINGS

Piezometer C-6
Ground Surface Elevation (M.P.) 244.3 ft.; 74.46 m
Top of Casing Elevation (M.P.) 251.8 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-22-83	Top of Casing	125.0	126.8
3-28-83	Top of Casing	124.0	127.8
3-31-83	Top of Casing	127.5	124.3
4-4-83	Top of Casing	126.5	125.3
4-8-83	Top of Casing	126.0	125.8
4-12-83	Top of Casing	125.6	126.2
4-13-83	Top of Casing	125.3	126.5
5-25-83	Top of Casing	120.0	131.8
7-21-83	Top of Casing	114.0	137.8
8-20-83	Top of Casing	111.35	140.45
8-25-83	Top of Casing	111.0	140.8
9-1-83	Top of Casing	110.4	141.4

WATER LEVEL READINGS

Piezometer C-15
Ground Surface Elevation (M.P.) 279.9 ft.; 85.32 m
Top of Casing Elevation (M.P.) 282.8 ft.
Aquifer Screened Ponce Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-25-83	Ground Surface	259.5	20.4
3-28-83	Ground Surface	259.5	20.4
3-28-83	Ground Surface	259.8	20.1
3-31-83	Ground Surface	259.8	20.1
4-4-83	Ground Surface	259.7	20.2
4-8-83	Ground Surface	258.3	21.6
4-12-83	Top of Casing	262.8	20.0
4-13-83	Top of Casing	262.7	20.1
5-25-83	Top of Casing	263.17	19.63
7-21-83	Top of Casing	262.6	20.2
8-20-83	Top of Casing	263.49	19.31
8-25-83	Top of Casing	263.7	19.1
9-1-83	Top of Casing	263.6	19.2

WATER LEVEL READINGS

Piezometer C-16
Ground Surface Elevation (M.P.) 220.2 ft.; 67.1 m
Top of Casing Elevation (M.P.) 223.6 ft.
Aquifer Screened Juana Diaz Formation

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
3-25-83	Ground Surface	167.5	52.7
3-28-83	Ground Surface	130.0	90.2
4-4-83	Ground Surface	104.7	115.5
4-8-83	Ground Surface	101.5	118.7
4-12-83	Top of Casing	101.8	121.8
4-13-83	Top of Casing	101.8	121.8
5-25-83	Top of Casing	99.39	124.16
7-21-83	Top of Casing	97.3	126.25
8-20-83	Top of Casing	96.95	126.6
8-25-83	Top of Casing	96.8	126.75
9-1-83	Well vandalized no reading possible due to obstruction above water table	-	-
7-15-88	Top of Casing	93.94	129.66

WATER LEVEL READINGS

Monitoring Well: MW-1
Ground Surface Elevation (M.P.): 252.87 ft.; 77.08 m
Top of Casing Elevation (M.P.): 255.70 ft.
Aquifer Screened: Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
8-12-83	Top of Casing, 24 Hours After Well Installation	86.83	168.87
8-15-83	Top of Casing, Prior to Development	99.79	155.91
8-15-83	Top of Casing, Immediately After Development	116	139.7
8-18-83	Top of Casing, Prior to Bailing	101.08	154.62
8-18-83	Top of Casing, Immediately After Bailing	128.08	127.62
8-19-83	Top of Casing, Prior to Washing Hole With Rig	108.67	147.03
8-19-83	Top of Casing, After Bailing To Remove Drill Water	114.67	141.03
8-20-83	Top of Casing	102.01	153.69
8-25-83	Top of Casing	111.0	144.7
9-1-83	Top of Casing	114.5	141.2
9-13-83	Top of Casing	125.08	130.62
9-20-83	Top of Casing	128.58	127.12
10-20-87	Top of Casing	118.14	137.56
7-15-88	Top of Casing	117.95	137.75

WATER LEVEL READINGS

Monitoring Well: MW-2
Ground Surface Elevation (M.P.): 230.41 ft.; 70.23 m
Top of Casing Elevation (M.P.): 235.36 ft.
Aquifer Screened: Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
8-12-83	Top of Casing, Water Level After Taking 29 Ft. Sample, Drilled With Air	27.08	208.28
8-12-83	Top of Casing, at 0915 Hours	26.83	208.53
8-12-83	Top of Casing, at 0930 Hours	25.17	210.19
8-12-83	Top of Casing, at 0945 Hours	24.67	210.69
8-13-83	Top of Casing	36.11	199.25
8-18-83	Top of Casing	37.2	198.16
8-18-83	Top of Casing, 100 Bails Later	37.1	198.26
8-19-83	Top of Casing	37.2	198.16
8-20-83	Top of Casing	37.1	198.26
8-25-83	Top of Casing	36.5	198.86
9-1-83	Top of Casing	36.3	199.06
9-13-83	Top of Casing	36.92	198.44
9-20-83	Top of Casing	37.5	197.86
10-20-87	Top of Casing	42.79	192.57
7-15-88	Top of Casing	40.80	194.56

WATER LEVEL READINGS

Monitoring Well: MW-3
Ground Surface Elevation (M.P.): 232.86 ft.; 70.98 m
Top of Casing Elevation (M.P.): 236.78 ft.
Aquifer Screened: Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
7-27-83	Top of Casing, Water Level Measured After Blowing Hole With Air	64	172.78
7-28-83	Top of Casing, 24 Hours TOB	51	185.78
8-1-83	Top of Casing	53.54	183.24
8-3-83	Top of Casing	53.65	183.13
8-5-83	Top of Casing	53.72	183.06
8-8-83	Top of Casing	53.72	183.06
8-9-83	Top of Casing	53.81	182.97
8-12-83	Top of Casing	54.03	182.75
8-16-83	Top of Casing	54.25	182.53
8-18-83	Top of Casing	54.46	182.32
8-18-83	Top of Casing, Water Level After 31 Bails	82.25	154.53
8-18-83	Top of Casing, 1605 Hours	70.75	166.03
8-19-83	Top of Casing	57.56	179.22
8-20-83	Top of Casing	55.64	181.14
8-25-83	Top of Casing	55.4	181.38
9-1-83	Top of Casing	54.9	181.88
9-13-83	Top of Casing	55.33	181.45
9-20-83	Top of Casing	55.0	181.78
10-20-87	Top of Casing	54.77	182.01
7-15-88	Top of Casing	53.68	183.10

WATER LEVEL READINGS

Monitoring Well: MW-4
Ground Surface Elevation (M.P.): 237.66 ft.; 72.44 m
Top of Casing Elevation (M.P.): 242.84 ft.
Aquifer Screened: Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
8-2-83	Top of Casing, Water Level After Blowing Open Hole With Air to Remove Drilling Water	83	159.84
8-3-83	Top of Casing, 24 Hours TOB Open Hole	71	171.84
8-5-83	Top of Casing	55.31	187.53
8-8-83	Top of Casing	65.7	177.14
8-9-83	Top of Casing	65.54	177.3
8-12-83	Top of Casing	70.75	172.09
8-15-83	Top of Casing, Prior to Air Development	66.33	176.51
8-16-83	Top of Casing, 24 Hours After Air Development	68.5	174.34
8-18-83	Top of Casing, Prior to Development	73.0	169.84
8-18-83	Top of Casing, After 62 Bails	73.66	169.18
8-18-83	Top of Casing, Recovery After Bailing	73.49	169.35

WATER LEVEL READINGS

Monitoring Well	MW-4
Ground Surface Elevation (M.P.)	237.66 ft.; 72.44 m
Top of Casing Elevation (M.P.)	242.84 ft.
Aquifer Screened	Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
8-19-83	Top of Casing, 24 Hours After Development	73.17	169.67
8-20-83	Top of Casing, 24 Hours After Permeability Test	73.0	169.84
8-25-83	Top of Casing, 4 Days After Sampling	72.0	170.84
9-1-83	Top of Casing	72.6	170.24
9-13-83	Top of Casing	73.17	169.67
9-20-83	Top of Casing	73.5	169.34
10-20-87	Top of Casing	91.60	151.24
7-15-88	Top of Casing	66.46	176.38

WATER LEVEL READINGS

Monitoring Well: MW-5
Ground Surface Elevation (M.P.): 187.95 ft.; 57. m
Top of Casing Elevation (M.P.): 192.35 ft.
Aquifer Screened: Alluvium, Ponce

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
8-25-83	Top of Casing	60.4	131.95*
9-1-83	Top of Casing	60.4	131.95*
9-13-83	Top of Casing	60.25	132.1
9-20-83	Top of Casing	59.67	132.68
10-20-87	Top of Casing	39.27	153.08
7-15-88	Top of Casing	61.38	130.97

* Dry when installed

WATER LEVEL READINGS

Monitoring Well	MW-6
Ground Surface Elevation (M.P.)	252 ft., 77 m
Top of Casing Elevation (M.P.)	250 ft., 76 m
Aquifer Screened	Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
4- -84		203.9	46.1
10-20-87		192.6	57.4
7-15-88	Top of Casing	168.42	81.58

WATER LEVEL READINGS

Monitoring Well	MW-7
Ground Surface Elevation (M.P.)	312 ft., 95 m
Top of Casing Elevation (M.P.)	304 ft., 93 m
Aquifer Screened	Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
4- -84		134.4	169.6
10-20-87		123.1	180.9
7-15-88	Top of Casing	105.54	198.46

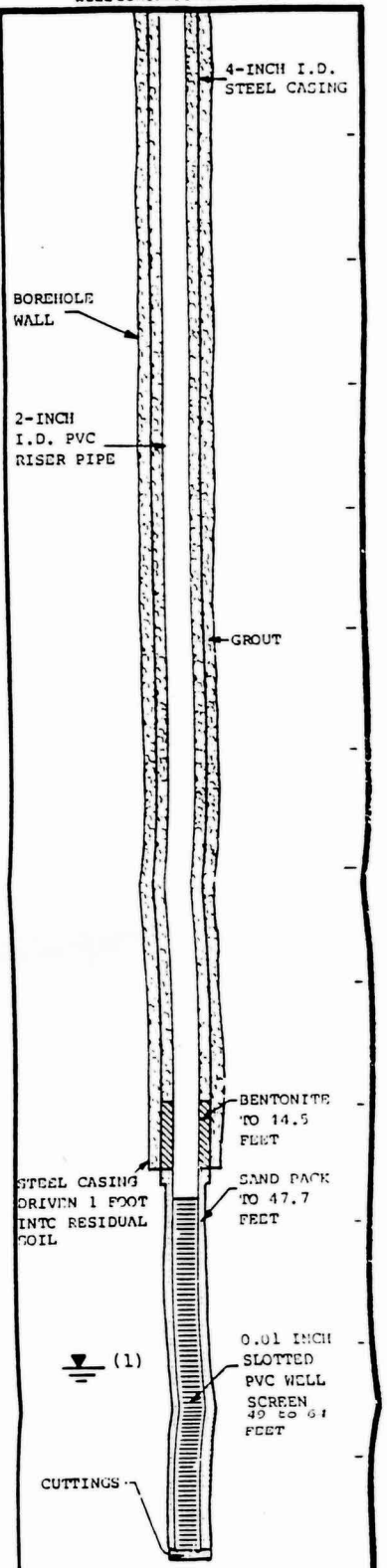
WATER LEVEL READINGS

Monitoring Well	MW-8
Ground Surface Elevation (M.P.)	397 ft., 121 m
Top of Casing Elevation (M.P.)	399 ft., 122 m
Aquifer Screened	Juana Diaz

DATE	M.P./REMARKS	WATER LEVEL BELOW M.P. (ft.)	ELEVATION OF WATER LEVEL (ft.)
4- -84		245.0	154.0
10-20-87		243.5	155.5
7-15-88	Top of Casing	244.90	154.10

TEST BORING RECORD

ELEV FT	DEPTH FEET	STRATA DESCRIPTION	FORMATION	"N" VALUE
187.9		WASTE-FILL-OCCASIONAL LAYERS OF SANDY FILL. EXPLOSIVE GASES PRESENT.	FILL	29
				16
				11
182.9				55/8"
				60/1"
				74/8"
177.9				11
				13
				12
172.9				23
				34
				19
167.9				23
				16
	22.5			27
		WASTE-FILL-BLACK EARTHEN FILL WITH TRASH FRAGMENTS. OCCASIONAL LAYERS OF PALE YELLOW ORANGE, GRAY AND BROWN EARTHEN FILL LAST 7 FEET OF SECTION. EXPLOSIVE GASES PRESENT.		33
162.9				10
				17
				65/8"
[illegible]				7
				32
				39
				31
152.9				11
				8
				16
147.9				15
				20
				16
142.9				11
	46.5			22
		ALLUVIUM-MOIST DARK BROWN FINE TO MEDIUM SANDY SILTY CLAY. SHELL FRAGMENTS COMMON.	ALLUVIUM	15
				16
137.9				26
	51.0	COLLUVIUM OR SEVERELY WEATHERED PONCE FORMATION - LIMESTONE FRAGMENTS AND BROWN CLAYEY SILT AND GRAYISH PINK FINE TO MEDIUM SAND.	PONCE	49
				49
132.9				107/8.5"
	56.0	RESIDUAL - LIMESTONE FRAGMENTS.		130/9"
127.9				
	60.0	VERY HARD MOIST PALE YELLOW ORANGE SILT CLAY. ABUNDANT ORANGE MOTTLING. SECONDARY CALCITE FILLING TWO SMALL VOIDS.		120/11"
	64.0	BORING TERMINATED AT 64 FEET.		



WELL CONSTRUCTION DETAILS

REMARKS:

(1) 2-28-84 Water Level

DRILLED BY Caribbean Soil Testing
LOGGED BY M. Parker
CHECKED BY L. Karably

BORING NUMBER MW-5
DATE STARTED 7/21/83
DATE COMPLETED 8/13/83
JOB NUMBER GS3223